

Technical Paper 324

LEVEL II

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INVESTIGATION OF THE STRENGTH OF ASSOCIATION BETWEEN GRAPHIC SYMBOLOGY AND MILITARY INFORMATION

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BATTLEFIELD INFORMATION SYSTEMS TECHNICAL AREA



U. S. Army

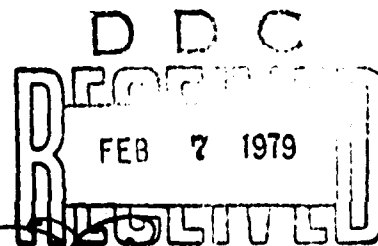
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September 1978

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Paper 324	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) INVESTIGATION OF THE STRENGTH OF ASSOCIATION BETWEEN GRAPHIC SYMBOLOGY AND MILITARY INFORMATION,		5. TYPE OF REPORT & PERIOD COVERED --
7. AUTHOR(s) Philip/Bersh, Temple University; Franklin L./Moses and Richard/Maisano, Army Research Institute		6. PERFORMING ORG. REPORT NUMBER --
9. PERFORMING ORGANIZATION NAME AND ADDRESS Army Research Institute for the Behavioral and So- cial Sciences, 5001 Eisenhower Avenue, Alexandria, Va. 22333, and Temple University, Philadelphia, Pa.		8. CONTRACT OR GRANT NUMBER(s) DAAG 29-76-D-0010 / <i>nu</i>
11. CONTROLLING OFFICE NAME AND ADDRESS Deputy Chief of Staff for Personnel Department of the Army Washington, D.C. 20310		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q161102B74F, 2Q762722A765
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) -- (12) 54p.1		12. REPORT DATE September 1978
		13. NUMBER OF PAGES 44
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE --
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited. (18) ARI (19) TP-324		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) --		
18. SUPPLEMENTARY NOTES --		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Symbols; Military Symbolology; Natural Language; Graphics; Automated Displays; Tactical Operations System (TOS); Computer Graphics		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This investigation sought to determine the strength of associations of simple codes or geometrical shapes with military concepts. Symbols were chosen for easy generation on computer displays or for ease of manual reproduction. Each of 114 enlisted men ranked battlefield information categories (e.g., Unit Level, Danger, and Firepower) in the order of their strength of association with different sets of symbols, with numbers of each set varying in a single		

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characteristic. In a related task, these persons were asked to rank order military branch or duty designations and tactical function terms by how well they were suggested by both geometrical symbols and miscellaneous "stick" symbols. A second group of 137 enlisted persons had the reverse task of ranking symbols against one another for their strength of association with military concepts. Both groups of participants had only limited prior exposure to military symbology.

Results suggest that "natural" associations can be found between graphic codes or symbols and military concepts. Results were categorized as high, medium, minimal, and insignificant associations, based on the statistical significance of differences among ranks and on the degree of reflexive associations between symbols and concepts.) About half of the primary matches between tactical concepts and symbols fell into high- and moderate-association categories. These matches included the currently used link between numerosity and Unit Level (e.g., company and division) as well as the link of color with Danger and of square with Service Support. The remaining association results, including the currently used associations of an ellipse with Armor, X with Infantry, and of color for Friend/Enemy, fell into the minimal- or insignificant-association categories. The data gathered identify symbol characteristics for consideration in modifying current symbology. Natural codes or symbols based on such a consensus should be easily learned and interpreted.

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**Office, Deputy Chief of Staff for Personnel
Department of the Army**

September 1978

**Army Project Numbers
2Q161102B74F
2Q762722A765**

**Tactical Operations &
Displays**


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FOREWORD

The Battlefield Information Systems Technical Area is concerned with the future battlefield demands for increasing the man-machine capability of acquiring, transmitting, processing, disseminating, and utilizing information. The research focuses on the problems of interfacing and interacting within command and control centers. There is concern with such areas as topographic products and procedures, tactical symbology, user-oriented systems, information management, staff operations and procedures, and sensor systems integration and utilization.

Of special interest are human factors problems in developing and validating new symbology concepts for effective display of tactically significant information. There is a need for an ADP-compatible symbology that can communicate the status of the battlefield and its activity rapidly and easily. This present research developed a methodology and determined a basis for a more effective military symbology by taking advantage of natural associations that often exist between concepts and the symbols or codes used to represent them (e.g., red = Danger). This effort represents one phase in the exploration of improved ways to transmit information to users and provides part of the necessary technological base required for effective design of the user-systems interface.

Research in the area of symbolic representation of the tactical environment is conducted both in-house and contractually. Efforts in this area are responsive to general requirements of Army Projects 2Q762722A765 and 2Q76374A774 and to special requirements of the U.S. Army Combined Arms Combat Development Activity, Fort Leavenworth, Kans., and the U.S. Army Intelligence Center and School, Fort Huachuca, Ariz. This specific effort was conducted under Army Project 2Q161102B74F as basic research responding to the above requirements.


JOSEPH ZEIDNER
Technical Director

INVESTIGATION OF THE STRENGTH OF ASSOCIATION BETWEEN GRAPHIC SYMBOLOGY AND MILITARY INFORMATION

BRIEF

Requirement:

To investigate the existence of "natural" associations between graphic symbology and military concepts.

Procedure:

Each of 114 enlisted men ranked battlefield information categories (e.g., Unit Level, Danger, and Firepower) in the order of their strength of association with different sets of symbols, with members of each set varying in a single characteristic. In related tasks, these persons were asked to rank order military branch or duty designations and tactical function terms by how well they were suggested by both geometrical symbols and miscellaneous "stick" symbols. A second group of 137 enlisted men had the reverse task of ranking symbols against one another for their strength of association with military concepts. The participants, from the 3rd Infantry (The Old Guard), had only limited prior exposure to military symbology. Results were categorized as high, medium, minimal, and insignificant associations, based on the statistical significance of differences among ranks and on the degree of reflexive associations between symbols and concepts.

Findings:

Results suggest that "natural" associations can be found between graphic codes or symbols and military concepts. About half of the primary matches between tactical concepts and symbols fell into the high- and moderate-association categories. High associations are those that show little or no ambiguity about which symbol and concept belong together. The three high-association categories were (1) the currently used link between numerosity (number of lines) and Unit Level (e.g., company, division), (2) the link of color with Danger, and (3) the link of a square with Service Support. All moderate associations had at least some ambiguity. A noteworthy cluster of four symbols was associated with the Maneuver Unit concept. These same four symbols were also associated with 8 out of 10 other military branch or duty designations. The other half of the association results, including the currently used associations of an ellipse for Armor, an X for Infantry, and of color for Friend/Enemy, fell into the minimal- or insignificant-association categories.

Utilization of Findings:

The data gathered identify symbol characteristics that should be considered when modifying the current symbology system. Such natural codes or symbols would have a built-in advantage for the display of military concepts because they presumably could be learned and interpreted more readily.

This ranking technique for matching symbols and concepts appears to be a suitable method to assess traditional symbology systems and new symbology ideas.

INVESTIGATION OF THE STRENGTH OF ASSOCIATION BETWEEN GRAPHIC SYMBOLOGY
AND MILITARY INFORMATION

CONTENTS

	Page
INTRODUCTION	1
BACKGROUND	2
METHOD	4
Participants	4
Task	4
Symbols	4
Rationale for Symbols	5
Concepts	5
Rationale for Concepts	5
Task Organization	6
RESULTS AND DISCUSSION	6
High-Association Strength	7
Moderate-Association Strength	10
Minimal- or Insignificant-Association Strength	11
CONCLUSIONS	11
REFERENCES	13
APPENDIX A. SYMBOLS, CONCEPTS, AND INSTRUCTION	
FORMS A & B	15
B. MEAN RANKS, PERCENTAGES OF "BEST" RANKS, AND SIGNIFICANCE RESULTS	31
DISTRIBUTION	41

	LIST OF TABLES	Page
Table 1.	Salient perceived concept-symbol associations	8
2.	Minimal or insignificant perceived concept-symbol associations	9
B-1.	Rank order of associations between information categories and each symbol set	32
B-2.	Rank order of associations between branch designations and each geometric form	33
B-3.	Rank order of associations between branch designations and each miscellaneous symbol	34
B-4.	Rank order of associations between general function terms and each geometric form	35
B-5.	Rank order of associations between general function terms and each miscellaneous symbol	36
B-6.	Rank order of associations between symbol sets and each information category	37
B-7.	Rank order of associations between geometric forms and each branch designation	38
B-8.	Rank order of associations between miscellaneous symbols and each branch designation	39
B-9.	Rank order of associations between geometric forms and each general function term	40
B-10.	Rank order of associations between miscellaneous symbols and each general function term	41

LIST OF FIGURES

Page


Figure A-1. Symbol sets	15
A-2. Geometric forms	16
A-3. Miscellaneous "stick" symbols	17



AN INVESTIGATION OF THE STRENGTH OF ASSOCIATION BETWEEN GRAPHIC SYMBOLOGY AND MILITARY INFORMATION

INTRODUCTION

The advent of automated data processing (ADP) systems has greatly increased the amount and rate of information that can be shown to a commander. However, many of the advantages of ADP and computer-generated displays will be lost unless efficient graphic codes and symbology are developed. Military symbols can be improved both to allow broader uses and to permit more informative tactical displays. Current symbol details often have low recognition value, and even basic information can quickly clutter a display.

For example, consider the coding complexity possible with tactical symbols. A symbol may contain information about the next higher echelon, the unit designation, and other details that supplement the basic unit size, type, and location. These details quickly create a cluttered display and may obscure the information that is most important for the commander. Many of the details even require a manual for interpretation. Despite such details, the main communication to a user concerns the identity and location of a unit. Information concerning mission capability and effectiveness is not explicitly communicated. In general, there is a need for a symbology system that is easily communicated, reveals the status of the battlefield and its activity readily, and permits informative automated displays.

The graphic codes and symbols now used have evolved through history. Department of the Army Field Manual 21-30, "Military Symbols," (1965) shows codes and symbols selected for their supposed iconic representation--such symbols as X to suggest the crossed rifles of the Infantry insignia and  to represent the track of armored vehicles. Such an approach is based upon the reasonable assumption that codes and symbols with implicit associations already existing or easily formed will be immediately recognizable or readily learned. Dissatisfaction with conventional symbology has particularly sparked interest for considering symbology in terms of clarity, simplicity, consistency, and adequacy for computer generation. Unfortunately, there is little or no empirical evidence available for accepting any new approaches or for retaining conventional symbology.

The present investigation explored tendencies to associate simple graphic codes or symbols with concepts. Common cultural influences often lead to the formation of more or less stereotypical associations between information and visual stimuli or stimulus patterns. The word "natural" can be used to describe such associations. For example, to most American motorists, green means go and red means stop. Most adults would associate a meniscus  with the moon and with nighttime, while a circle with lines emanating from its circumference  would be associated with

the sun and with daytime. When associations are natural in this way, a graphic code or symbol will evoke its information associate with high probability.

On the other hand, when an association is not natural, a graphic code or symbol will evoke information with low probability or not at all. A person's cultural background might hamper the learning and retaining of arbitrary associations. Cultural differences might also lead to different associations with the same visual material.

Both conveyance of information and natural associations are integral parts of the principle of Stimulus-Response (S-R) Compatibility. S-R Compatibility refers to human expectancies about what stimulus and response patterns belong together. It can be broken down into spatial, movement, and conceptual associations. This study is concerned with compatible conceptual associations stemming from two sources, intrinsic and culturally influenced associations. Intrinsic associations are those that do not have to be learned and are ready-made but often unrecognized. For example, a right-handed person wants controls on the right side. Culturally influenced associations, the category that the present research tested, are illustrated by the U.S. Army assignment of blue to Friend and red to Enemy (FM 21-30) and the equivalent Russian assignment of red to Friend in the reverse relationship of hue to information (Soviet Armed Forces Military Symbols, 1970).

BACKGROUND

Despite wide use of graphic codes and symbols, there is little research on how well symbols are associated with their intended meanings. One common way of choosing symbols for given applications is to select those that take advantage of already existing associations (Van Cott & Kinkade, 1972; McCormick, 1976). It is assumed that pictorial symbols, such as realistic silhouettes, will strongly suggest the objects or events to be symbolized. Mead and Modley (1968) labeled such symbols "image related," pointing out that their usefulness may diminish with time, particularly if the symbolized objects become technologically obsolete or changed for reasons of fashion. "Concept-related" symbols (e.g., a right-turn arrow), on the other hand, are likely to remain effective indefinitely. Furthermore, properly chosen concept-related symbols are as readily and perhaps even more universally understood than image-related symbols. Both image-related and concept-related symbols have played a major role in efforts to develop universal graphic languages (Modley, 1966; Mead & Modley, 1968) or international road signs (McCormick, 1976).

The fact that a symbol is pictorial by no means guarantees its connection with an intended associate. Kolers (1969) has emphasized the grossly exaggerated status of claims for the "immediacy" or "directness" of what he calls "pictograms." Indeed, the information conveyed by any

symbol depends on a viewer's experience and knowledge, as determined to a considerable degree by the culture of his or her society.

Even a symbol as apparently clear in its meaning as a directional arrow may be interpreted in nondirectional terms because of cultural influences (Kolers, 1969). Kolers has, in fact, asserted that the Sapir-Whorfian hypothesis (Whorf, 1956), currently applied only to the critical role of cultural differences in the interpretation of verbal material, should also be applied to pictorial material. The hypothesis states that language defines thinking and transmits culture among people. Thus, language may define our view of the world and set bounds on our behavior. It follows from this premise that as culture and language change, our view of the world changes. For example, English-speaking peoples have at most four or five ways to describe and communicate the idea of snow, while Eskimos have about 22 one-word definitions for this concept because of the central position it holds in their culture. Thus, there is reason to suggest that cultural "preparedness" affects human association in a manner analogous to the influence of genetic "preparedness" upon the formation of associations in animals (Seligman, 1970).

Such considerations strongly indicate the advisability of testing graphic codes and symbols for the associations they evoke before selecting them to display information to any group of users. Existing studies have explored information processing with the aid of graphic displays (e.g., Ringel et al., 1966) or have compared different types of graphic codes and symbols with each other (Smith & Thomas, 1964) and with alphanumeric symbols (Hitt, 1961). However, limited research has tested the information value of graphic symbology, particularly with military information. In one effort, Wheatley (1977) tested the salience of complex graphic symbols by using three different dimensions for conveying the impression of hostility. The dimensions were shape (spikiness), color, and numerals, each in seven ascending levels of hostility. After being told how each dimension was used to express hostility, participants were asked to indicate which member of complex symbol pairs expressed the greater hostility. In fact, the symbol pairs had been constructed to be equal by varying the levels of the three dimensions. The results showed that shape and color were superior to numerals for affecting hostility perception. Though the difference was small, shape was used more often than color. Wheatley noted that participants usually concentrated on a single dimension in their judgments rather than trying to evaluate all three.

In another approach to symbology research, Berry and Horowitz (1961) asked participants to draw symbols and diagrams to represent their interpretation of 30 topographic features. Over half the participants drew approximately the standard symbols for only 11 of the 30 features, inventing nonstandard symbols for the rest. Many of the new self-created symbols for the remaining 19 features were the same or similar. An average of 63% of the participants independently drew identical or similar symbols for four features. For nine other features, more participants independently drew an identical or similar new symbol than the standard

symbol. The authors concluded that standard symbols were ineffective in representing topographic information for the unskilled participants and inadequate for even the skilled participants. In addition, the authors noted that participants who agreed on an independent interpretation drew the symbols as viewed from ground level. The results reflected wide differences among participants, some of whom may have found the task of drawing symbols for unfamiliar topographic terms too demanding. In this present research, both information and graphic symbology were explicitly provided to participants.

METHOD

Participants

Two separate groups of enlisted men E2 to E5 in grade participated. There were 114 persons in one group and 137 in the other group. Both groups were from the 3rd Infantry (The Old Guard), an honor guard unit stationed at Fort Myer, Va. They had only limited prior exposure to military symbology.

Task

Each participant was given a booklet containing three types of graphic symbology and three types of verbal material (Appendix A). The booklet for the first group showed a different graphic symbol or set of symbols at the top of each page followed by a number of different verbal concepts. Participants were asked to rank order the verbal concepts according to how well they were represented by the symbol shown. Participants in the second group were given the reverse task. Booklets for the second group showed one verbal concept per page followed by a number of symbol types to be rank ordered according to how well they represented a given concept. A ranking approach was used to provide data on the relative strength of the associations.

Symbols

The research symbology consisted of (a) seven symbol sets (e.g., circles, lines, and bars), with the members of each set varying in a single characteristic; (b) eight geometric forms; and (c) a miscellaneous group of eight "stick" symbols, some of which were segments of the geometric forms. The changing feature of each symbol set was designed to represent a dimension of stimulus variation that is indicated by labels in Appendix A.

Rationale for Symbols

Symbol characteristics either (a) represented a variety of easily reproducible changing features (e.g., color, size, and gray scale) or (b) included basic geometric forms (e.g., circle, square, and trapezoid) and plain stick figures (e.g., line, arrow, and angle) that could be used for building symbols. The material was kept simple so that each symbol might be generated readily by computer or easily reproduced manually with crayon or grease pencil.

Concepts

The verbal concepts included (a) information categories (e.g., Danger, Importance, and Friend/Enemy), some of them abstract; (b) military branch or duty¹ designations (e.g., Armor, Engineer, and Aviation); and (c) general military function terms (e.g., Combat Support, Fire Support, and Maneuver Unit). The information categories were defined, and the definitions and supplementary terms also made clear that they represented dimensions along which information might vary. For example, accuracy varied from "doubtful" to "certain." Two of the information categories, Friend/Enemy and Range, were represented as dichotomous. Range, for example, distinguished only between forces inside and outside of the striking range of enemy weapons. Participants were told to use only the first and last members of each symbol set in providing their ranking on these two categories. The general military function terms also were defined, and examples of the types of military unit performing each function were included in the definitions (see Appendix A). Symbol sets were presented only with the information categories, whereas the geometric forms and miscellaneous symbols were used with both the branch designations and general function terms.

Rationale for Concepts

The tested military concepts or categories were chosen primarily by sampling the commonality of requirements from the U.S. Army Intelligence Center and School (Fort Huachuca, Ariz.) and the U.S. Army Combined Arms Combat Development Activity (Fort Leavenworth, Kans.). The information categories were selected because they constitute types of information potentially valuable for display, particularly to higher echelon commanders. With the exception of Friend/Enemy and possibly Range, such information is not currently displayed. Military branch designations represented the standard content of existing displays. Finally, general military function terms were included on the assumption that a higher echelon commander might want a display that would provide the disposition of enemy forces

¹The term "branch" is used to designate branch or duty performance functions as defined in Appendix C of FM21-30.

in terms of their generic combat functions--a display that might facilitate decisionmaking on the commitment of the commander's own forces. Displays that provide only specific branch and unit designations often tend to be confusing because of the clutter involved.

Task Organization

Each booklet was divided into two parts, Form A and Form B (see Appendix A). In the Form A booklet, each page of Part I presented one symbol set together with eight information categories; each page of Part II presented an individual symbol together with nine branch designations or three general function terms. The verbal material was arranged in four different orders to guard against the tendency to rank in a manner dependent upon the order in which the items were listed. In the Form B booklet, each page of Part I presented one information category. Because the seven symbol sets to be rank ordered included colors, the symbol sets were printed on a detachable page to reduce the printing cost. Each page of Part II presented a branch designation or general function term together with the eight geometric forms or the eight miscellaneous symbols. Four orders of the geometric forms and the miscellaneous symbols were employed.

Participants were given both oral and printed instructions (see Appendix A for the printed instructions). The oral instructions were designed to insure that participants understood the proper way to use the machine-scored answer sheets. Participants were informed that the exercise was not a test of their knowledge of military symbology, that there was no "correct" way to rank the items, and that they should treat each page independently. Finally, the oral instructions emphasized that immediate impressions were desired. No time limit was set. Participants required from 20 to 75 minutes to complete the exercises.

RESULTS AND DISCUSSION

Data analyses of these test results suggest that natural and consistent associations of graphic symbols with verbal concepts can be found that are relevant to the Army's needs. Overall differences in mean rank were analyzed with Friedman's non-parametric analysis of variance (Siegel, 1956), and each significant set of rankings was further analyzed with the a posteriori Nemenyitest (Kirk, 1969) of pair-wise comparisons. In addition, the percentage of participants who ranked items as "best" was calculated. Mean ranks, percentages of "best" rankings, and significance results were tabulated (Appendix B) and used in further aggregations of results.

The associations discovered by this research were based on two separate groups of rankings of graphic symbology features and verbal concepts. The second group's task, which placed the seven symbol sets in direct competition for their strength of association with a verbal concept, identified one type of preference. The first group's task, however, allowed for

a check on associations by requiring the ranking of various word concepts with respect to each symbol type. Both kinds of rankings are necessary to decide about the "best" symbol code, particularly in the case of ties.

Four indicators were developed to define the "best" symbol-concept associations for the tested items. The criteria were (a) a statistically best mean rank (i.e., a rank significantly different from that of any other possible association), (b) a mean rank significantly better than that of other possible associations, (c) a first-place ranking by the greatest number of participants, and (d) fulfillment of either (a) or (b) and of (c) for both the order in which symbol types were ranked with each concept and the order in which word concepts were ranked with each symbol type (i.e., a two-way association).

Three associations of high strength were supported by all four criteria, and numerous associations of moderate strength were partially supported (see Table 1). Some of the associations with minimal or insignificant support are shown in Table 2. The associations shown are not recommendations for implementation but are illustrations of the principal trends found in the appended tables of results (see Appendix B).

High-Association Strength

Ideally, a given graphic code or symbol should represent only one concept or item of information. It would be confusing if the same code or symbol represented different concepts or items of information on the same display. Therefore concept-symbol associations having relatively little ambiguity are considered strongest. For example, the association of numerosity (i.e., number of lines) with Unit Level was particularly strong and clearly supported the current military coding scheme for designating units. In addition to the correlation of numerosity with Unit Level, the relationships of color with Danger and square with Service Support were quite good. However, most of the present research results contained some level of ambiguity. Some of the primary associations in the data were stronger than others; this was the basis for organizing Tables 1 and 2.

Care must be taken to consider these data highlights within their proper context. For example, although color was the statistically best association for Danger and Danger ranked high as an associate for color, there are other relevant aspects of the data. Consider that color often was chosen to represent the concepts of Friend/Enemy, Accuracy, and Importance (see Appendix B). Conversely, a color symbol evoked the concepts of Concentration and Importance as containing statistically significant associations. Color seemed to symbolize a broader concept than Danger; perhaps it could be labeled "Threat." These associations are understandable, given the role of red as a warning and green as a signal of safety in our society. In addition, these data suggest that color is a powerful way to symbolize battlefield information other than Friend/Enemy, its principal current use. Such multiple relationships show that

Table 1. SALIENT PERCEIVED CONCEPT-SYMBOL ASSOCIATIONS

Directional Relationships				% Assigning 1st-Place Rank	
Concept	Statistically Best (p < .001)	Statistically Significant (p < .01)	Symbol	Concept	Symbol
Unit Level	↔		Numerosity ^a	57	50
Danger	→	→	Color	39	64
Service Support	→	→	Square	61	19
Service Support	→		Circle	47	22
Fire Support	→		Plus	47	16
Maneuver Unit	→		Parallelogram	57	10
	→		Angle	59	23
		↔	Arrow	57	37
		↔	Triangle	45	34
		↔	Gray Scale	36	28
		↔	Angle	17	23
		↔	Bracket	25	29
		↔	Diamond	26	36
		↔	Zigzag ^a	24	44
		↔	Parallelogram	23	21
				a Current Symbol for Concept	

High Association

Moderate Association

Two Way Association

Direction of Association

Table 2. MINIMAL OR INSIGNIFICANT PERCEIVED CONCEPT-SYMBOL ASSOCIATIONS

Directional Relationships			% Assigning 1st-Place Rank
Concept	Statistically Best ($p < .001$)	Statistically Significant ($p < .01$) Symbol	Concept Symbol
Friend/Enemy	→	Color ^a	14 41
Importance	→	Color	15 39
Air Defense Artillery	→	Triangle	16 39
	→	Angle	16 30
Accuracy	→	Color	5 38
Infantry	→	X ^a	36 23
	→	Angle	11 33
Signal Unit	→	Circle	34 24
Range	→	Size	15 33
Armor	→	Ellipse ^a	29 18
	→	Trapezoid	31 21

Minimal Association

6

Insufficient Association

↔ Two Way Association

→ } Direction of Association
←

^a Current Symbol for Concept

the primary concept-symbol association is no more than a starting point for selecting symbols for tactical display.

Clearly, codes or symbols can have associations of some strength with more than one concept or item of information. As the primary association weakens, other reasonable alternatives emerge. The high association of Service Support with square shows a tendency in this direction. Notice that Service Support is a statistically best associate for square. However, only 19% of the participants chose the opposite association of square for the concept of Service Support. In fact, a sizable portion of the participants liked circle and trapezoid almost as well (see Appendix B). The primary association with square was defined as the first-place-rank of that symbol combined with the strong reverse association. Would a circle symbol be as good as a square symbol to represent Service Support? The current data suggest that it probably would be, but future data may provide compelling reasons for using one over the other.

Moderate Association Strength

The second set of data (Table 1) is characterized by two subgroupings: (a) single associations that were statistically different from all other possible associations, and (b) groups of similarly ranked associations that had a statistically significant difference from associations with lower ranks. The categories can be somewhat misleading. For example, Service Support is shown under moderate associations as being the best associate for circle. This information must be tempered by the relationship of Service Support with square discussed earlier. Table 1 implies a weaker association between circle and Service Support by showing only a one-way association, but the data show only a minimal difference between square and circle as symbols for Service Support.

A more clearcut moderate association exists between Fire Support and the plus symbol. When participants chose a concept for the plus symbol, they may have thought of the cross-hairs used in targeting. Yet, the complementary association was not pronounced.

Symbols associated with the Maneuver Unit function seem to provide a basis for clustering a number of military branch designations. Maneuver Unit had its best association both with parallelogram and with angle. It also ranked first for arrow and triangle. All of these symbols except parallelogram connote movement and direction. In addition, their shapes are related to one another. In the case of the parallelogram symbol, the match with Maneuver Unit seems to fit the pattern, considering that this symbol has a good association with Mechanized Infantry and ranks near the top with Armor (see Appendix B). Perhaps the shape of a parallelogram suggests a tank. In general, the data revealed that these four symbols--parallelogram, angle, arrow and triangle--rank at the top for almost all military branches in this research. Two moderately strong associations occurred between Aviation and Angle and between Mech Infantry and parallelogram. With those exceptions, the clustering of symbols

for most branches makes the choice of associations between a particular symbol and a specific branch difficult.

Signal and Engineer, the only combat support branches included, did not follow the pattern of branch-symbol associations. For the Signal branch, participants preferred zigzag, somewhat like the current branch symbol, or diamond. The Engineer branch had a reasonable association with parallelogram, but the better match was with a bracket, a symbol related to the "E" currently used.

Minimal or Insignificant Association Strength

As Table 2 shows, there were a number of weak associations between symbols and concepts, including the current symbols of ellipse for Armor, X for Infantry, and color for Friend/Enemy. Because all participants were infantrymen, the choice of angle rather than X as a symbol for Infantry was particularly unexpected. Although the sample was small, these results emphasize the value of testing the strength of symbol-information associations now being used.

Half of the research results fall into the minimal- or insignificant-association category. This partially occurred because many of the symbols (e.g., color, circle, triangle, and angle) were highly preferred for more than one concept. In addition, the simplicity of the symbols used was probably a contributing factor. For some concepts (e.g., Firepower, Field Artillery, and Cavalry), no symbol ranked high enough for a clear primary association. This lack of association obviously limits research that attempts to explore relations between graphic symbols and concepts. Because a symbol is often chosen on a common-sense basis, there is no guarantee that a match between a given concept and any one symbol will be found.

CONCLUSIONS

In the present investigation, no special effort was made to select symbols for their iconic character. Instead, selection encompassed a variety of simple codes and symbols and a representative list of military concepts whose associations should be considered in modifying the current system. The salient associations found probably will be learned and interpreted easily by potential users. A limitation of the ranking approach is that results can be interpreted only within the range of symbols and concepts tested. For example, the outcome of symbol-concept rankings indicated that color has the strongest association with Danger; the conclusion, however, was limited by the choices available. Therefore, the introduction of new symbols and new items of information or other changes in the symbol or concept set would require a new evaluation.

There are more sophisticated ways to determine association strength than by the ranking procedures used here. More complex approaches, such as a paired-comparisons procedure (Thurstone, 1927), would have provided

more refined measurement at the cost of increased time and perhaps number of required participants. Instead, the ranking approach was used to reveal the existence of strong (stereotyped) associations for a variety of symbols and items of information. The ranking method certainly appears suitable for preliminary comparisons of the association value of military concepts with proposed and current symbology or with alternative proposed codes or symbols. The resulting data provide suggestions for symbol characteristics that should be considered in modifying the current symbology system.

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APPENDIX A

SYMBOLS, CONCEPTS, AND INSTRUCTION FORM A & B

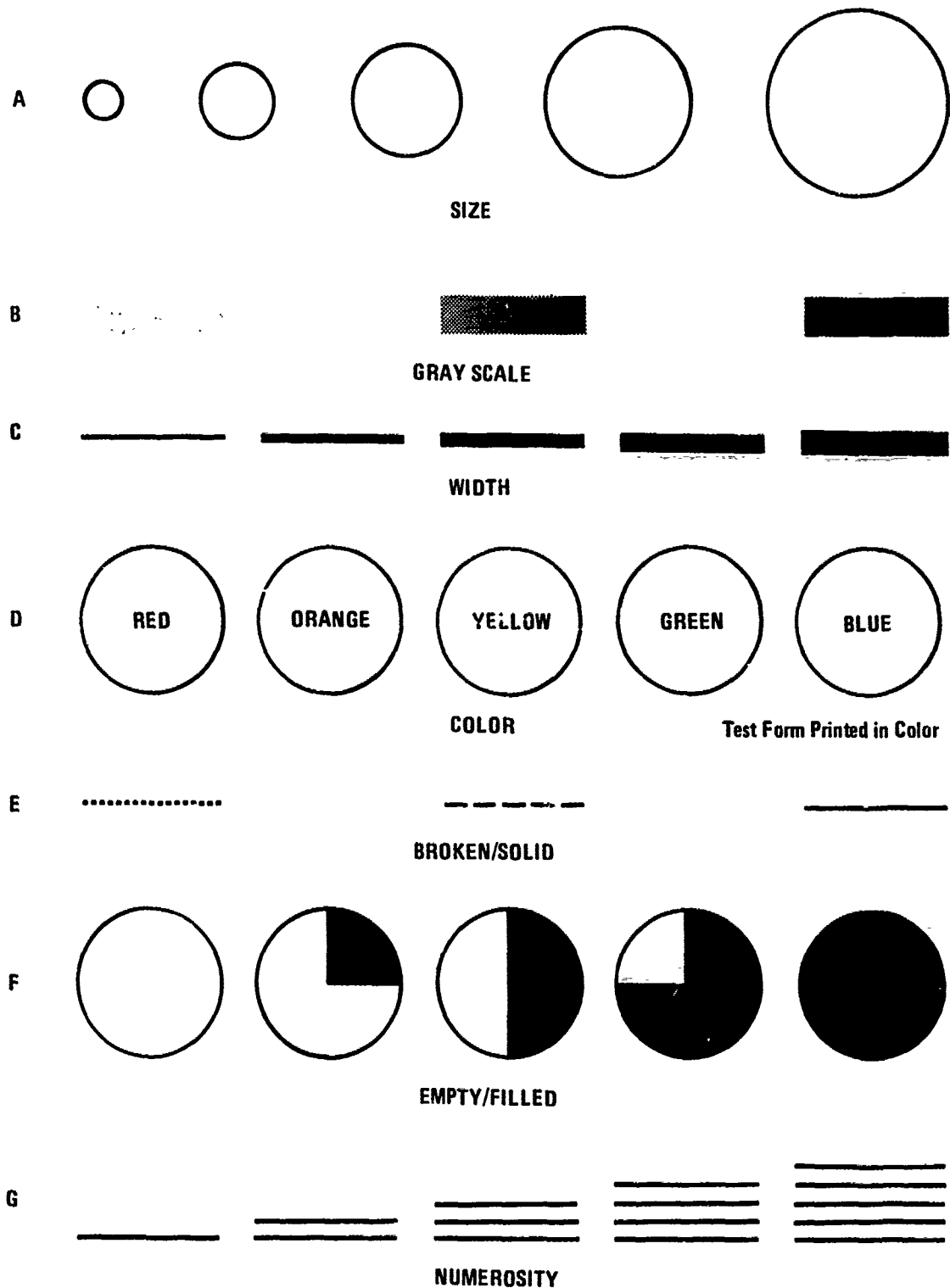


Figure A-1. Symbol sets.

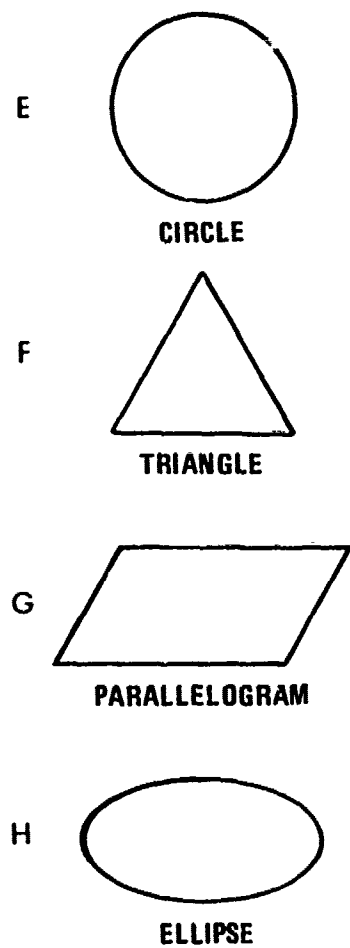
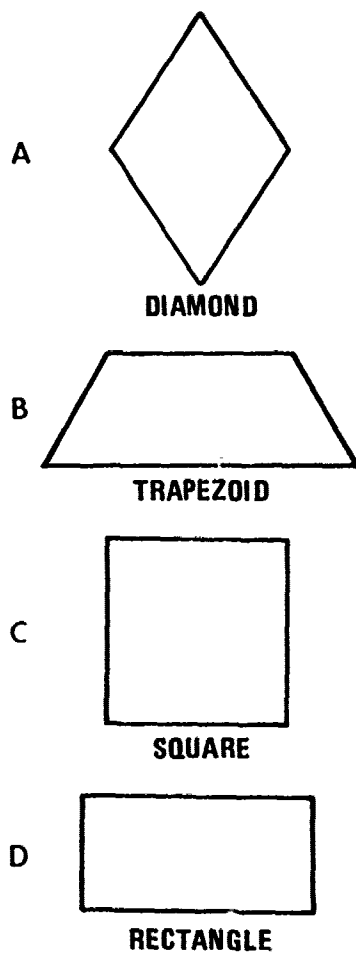


Figure A-2. Geometric forms.

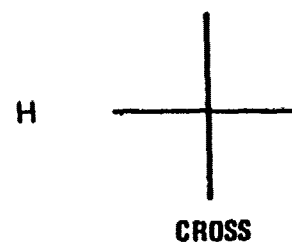
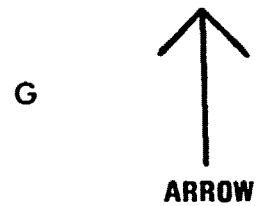
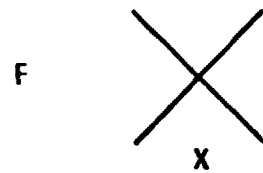
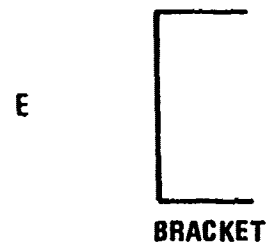
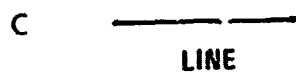
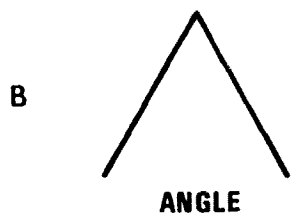


Figure A-3. Miscellaneous "stick" symbols.

INFORMATION CATEGORIES

- A. IMPORTANCE: Importance is the degree to which information requires attention and is critical to a situation. Related ideas: trivial-vital; insignificant-significant; irrelevant-relevant; unnecessary-necessary.
- B. ACCURACY: Accuracy is the degree to which information is known to be true or correct. Related ideas: doubtful-probable-certain; unconfirmed-confirmed; unreliable-reliable; tentative-firm.
- C. FIREPOWER: Firepower is the sum total of the destructive potential of all the weapons of a unit. Related ideas: individual destruction-mass destruction; low-medium-high capability to inflict damage and casualties.
- D. DANGER: Danger is the degree to which information or a situation indicates a potential for damage, injury or destruction. Related ideas: safe-dangerous; no risk-extreme peril.
- E. UNIT LEVEL: Unit Level is the organizational level of a military unit. Related ideas: Company-Division-Army; low level unit-high level unit.
- F. FRIEND/ENEMY: Consider only the left and right ends of the picture group. Friend/Enemy is the difference between friendly versus enemy forces. Related ideas: we-they; our side-their side.
- G. RANGE: Consider only the left and right ends of the picture group. Range refers to whether our forces are outside or within striking distance of enemy weapons. Related ideas: out of reach-within reach; cannot be hit-can be hit.
- H. CONCENTRATION: Concentration is the degree to which units, weapons, or vehicles congregate or cluster in a local area. Related ideas: scattered-concentrated; dispersed-massed; few-many in a local area.

MILITARY BRANCH DESIGNATIONS

- A. INFANTRY
- B. ARMOR
- C. FIELD ARTILLERY
- D. MECHANIZED INFANTRY
- E. SIGNAL
- F. ENGINEER
- G. AIR DEFENSE ARTILLERY
- H. CAVALRY
- I. AVIATION

GENERAL MILITARY FUNCTION TERMS

- A. SERVICE SUPPORT UNIT: Service Support Units are organizations or activities such as maintenance, supply, and field hospital that do not participate in combat directly but are used to provide support for maneuver and fire support units.
- B. MANEUVER UNIT: Maneuver Units are organizations such as armor or infantry used to attack, defend, and so forth.
- C. FIRE SUPPORT UNIT: Fire Support Units are organizations such as field artillery and air defense artillery used to place supporting fires on targets and to help insure the success of any particular maneuver.

FORM A

INSTRUCTIONS

The Army Research Institute (ARI) is in the process of conducting research on the improvement of military symbology used to describe tactical battlefield situations. We wish to have help from military personnel to find out what features the symbology should have. The project that you are participating in is designed to show us how military ideas and simple pictures relate to one another. A basic non-military example shows what we mean: the idea of daytime-nighttime is easily related to pictures of the sun and moon. We are interested in finding out what sort of pictures or symbols may be paired with military information.

No special training is required for the task--only your everyday past experience. You will not be graded or evaluated in any way. In fact, your name is not requested and should not be written on either the booklet or the answer sheets. The front of each booklet has its own three-digit identifying number in the upper right corner. Find Columns 77-79 on each of your answer sheets. Black out the numbered space corresponding to the first digit of your booklet identifier in Column 77, the second digit in Column 78 and the third digit in Column 79. Notice that each of your five answer sheets has a number printed above Column 80. They should be numbers 1, 2, 3, 4, and 5, respectively. Black out the corresponding numbered space in Column 80 of each answer sheet.

There are two parts of this exercise for you to complete:

PART I

On each page of Part I of the booklet, you will find one group of simple pictures and eight separate ideas. Each idea is labeled, and the label is followed by a definition of the idea. In addition, related words or phrases are provided to help you understand the meaning of the idea. Note that the picture group on the page changes from left to right in one of its features. Your task is to decide which idea is best represented by the picture group with its changing feature, which idea is second best, third best, and so on for all the ideas. We are not trying to find out if you know current military usage. We are looking for your own preferences.

The following example shows a picture group and defines three ideas.

EXAMPLE



Put the ideas in the order that best represents your feelings about the degree to which they are suggested or implied by the picture group and its changing feature.

- A. WORK: Work is the amount of effort involved in doing a task.
Related ideas: easy-hard; simple-difficult;
"no sweat"-strenuous.
- B. ALTITUDE: Altitude is the distance above ground.
Related ideas: low-high; ground-sky.
- C. CHILD-ADULT: Consider only the left and right ends of the picture group. Child-Adult refers to the difference between youth and age.
Related ideas: young-old; immature-mature.

The ideas are of two generally different types in the example as they will be in your task. Child-Adult emphasizes only the extremes of an idea; Work and Altitude have more levels of meaning. We have begun doing the example for you and have decided that idea B (altitude) is the idea most directly suggested or implied by the picture series. It has been marked on the sample form below. Notice that the space corresponding to "1" (first best) has been blackened under column B. Given that B is already selected, then in what order would you choose the remaining two ideas? Please make your choices and blacken the appropriate places on the sample form. Remember, there are no correct answers--only your honest judgments. Corrections can be made by completely erasing a mark. Two ideas on the same page should never be given the same preference number.

Page 0

A B C

• 0 •	• 0 •	• 0 •
• 1 •	• 1 •	• 1 •
• 2 •	• 2 •	• 2 •
• 3 •	• 3 •	• 3 •
• 4 •	• 4 •	• 4 •
• 5 •	• 5 •	• 5 •
• 6 •	• 6 •	• 6 •
• 7 •	• 7 •	• 7 •
• 8 •	• 8 •	• 8 •
• 9 •	• 9 •	• 9 •
1	2	3

Be very careful to mark the items correctly on the special answer forms. Each of the page numbers from the booklet appears in sequence above a section of the form. Letters identify the ideas on each booklet page. Mark your selected order for ideas in the correct lettered columns. It is important to note that the lists of ideas are arranged differently from page to page. Make sure that you do not stray to a wrong page number or column letter and that you give different rank orders to each item on a booklet page.

Please take special care in assigning the first four ranks to the listed ideas, but do your best to rank all of the remaining ideas also. Start ranking your preference from the best to the worst. If you have difficulty, perhaps choosing the best one or two and then the worst one or two would be helpful. It is important, however, to assign a rank to every item on a page. You will not be timed for this exercise. We ask you, insofar as possible, to base your rankings on your first impressions of the degree to which the ideas are suggested or implied by the picture group with its changing feature. Use your booklet as a scratch pad if you like.

Any questions? Raise your hand! When you have finished with Part I, please continue to Part II. There are instructions for you to read at that time.

PLEASE--RECORD YOUR PREFERENCES ON THE SPECIAL ANSWER SHEETS

FORM A

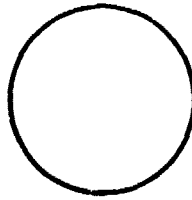
PART II

Instructions for Part II are similar to those for Part I. On each page of Part II of the booklet, you will find a single picture followed either by: (1) a list of labels which represent military branch designations (pages 8-23); or (2) a list of terms which indicate the function that a combat unit may perform (pages 24-39). In the first set of tasks, you have to decide which branch designation is best represented by the picture, which is second best, third best, and so on. In the second set of tasks, you have to decide the best order for relating unit functions to the picture. Function terms have been defined for you and examples are given of the military units which typically perform each function. Remember, we are not trying to find out if you know current military symbols. We are looking for your own preferences.

Note that the lists are arranged differently from page to page. After ranking a branch designation or function term with respect to its representation by a picture, black out the corresponding numbered space on the answer form in the same manner as described for Part I. Make sure that you do not stray to a wrong page number or column letter and that you give different rank orders to each item on a booklet page. Two ideas on the same page should never be given the same preference number.

Please take special care in assigning the first four ranks to the branch designations, but do your best to rank all of the remaining branch designations also. If you have difficulty, perhaps choosing the best one or two and then the worst one or two would be helpful. It is important, however, to assign a rank to every item on a page. You will not be timed for this exercise. We ask you, insofar as possible, to base your rankings on your first impressions of the degree to which the branch designations or function terms are suggested or implied by the picture. You may continue to use the booklet as a scratch pad if you like. Any questions? Raise your hand to alert us to any problems either now or during Part II. Start Part II when you are ready.

PLEASE---RECORD YOUR PREFERENCES ON THE SPECIAL ANSWER SHEETS



Do not assign the same preference order to more than one item. Put the following branch designations in the order that best represents your feelings about the degree to which the branch designations are suggested or implied by the picture:

- A. INFANTRY
- B. ARMOR
- C. FIELD ARTILLERY
- D. MECHANIZED INFANTRY
- E. SIGNAL
- F. ENGINEER
- G. AIR DEFENSE ARTILLERY
- H. CAVALRY
- I. AVIATION

(Example of Form A, Part II of the research)

FORM B

INSTRUCTIONS

The Army Research Institute (ARI) is in the process of conducting research on the improvement of military symbology used to describe tactical battlefield situations. We wish to have help from military personnel to find out what features the symbology should have. The project that you are participating in is designed to show us how military ideas and simple pictures relate to one another. A basic nonmilitary example shows what we mean: the idea of daytime-nighttime is easily related to pictures of the sun and moon. We are interested in finding out what sort of pictures or symbols may be paired with military information.

No special training is required for the task--only your everyday past experience. You will not be graded or evaluated in any way. In fact, your name is not requested and should not be written on either the booklet or the answer sheets. The front of each booklet has its own three-digit identifying number in the upper right corner. Find Columns 77-79 on each of your answer sheets. Black out the numbered space corresponding to the first digit of your booklet identifier in Column 77, the second digit in Column 78 and the third digit in Column 79. Notice that each of your five answer sheets has a number printed above Column 80. They should be numbers 1, 2, 3, 4, and 5, respectively. Black out the corresponding numbered space in Column 80 of each answer sheet.

There are two parts of this exercise for you to complete.

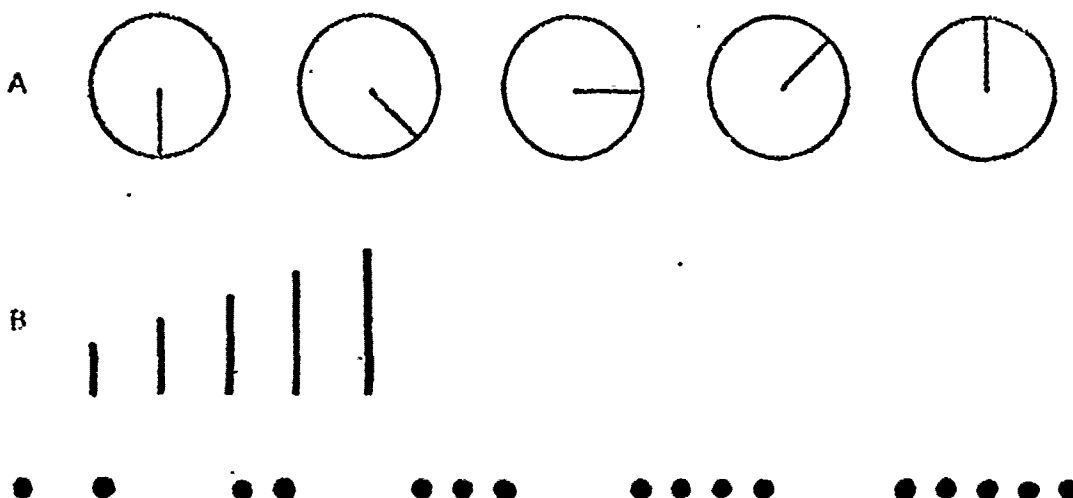
Part I

On each page of Part I of the booklet, you will find the label for an idea. The label is followed by a definition on the idea. In addition, related words or phrases are provided to help you understand the meaning of the idea. Each booklet also includes a page which contains seven picture groups. Note that each picture group changes from left to right in one of its features. Your task is to decide which picture group with its changing feature best represents the idea, which is second best, third best, and so on for all the picture groups. We are not trying to find out if you know current military usage. We are looking for your own preferences.

The following example defines an idea and then shows three picture groups.

ALTITUDE: Altitude is the distance above ground
Related ideas: low-high; ground-sky.

Put the picture groups (each with its changing feature) in the order that best represents your feelings about the degree to which they suggest or imply the idea.



We have begun doing the example for you and have decided that picture group B most directly suggests or implies the idea of altitude. It has been marked on the sample form below. Notice that the space corresponding to "1" (first best) has been blackened under Column B. Given that B is already selected, then in what order would you choose the remaining two picture groups? Please make your choices and blacken the appropriate places on the sample form. The example showed you one of two types of ideas which you will find in your task. Altitude has several levels of meaning. In contrast, some ideas such as Friend-Enemy emphasize only the extreme of an idea. Remember, there are no correct answers--only your honest judgments. Corrections can be made by completely erasing a mark. Two pictures should never be given the same preference number in indicating the degree to which they suggest or imply the idea on the page.

A B C

• 0 •	• 0 •	• 0 •
• 1 •	• 1 •	• 1 •
• 2 •	• 2 •	• 2 •
• 3 •	• 3 •	• 3 •
• 4 •	• 4 •	• 4 •
• 5 •	• 5 •	• 5 •
• 6 •	• 6 •	• 6 •
• 7 •	• 7 •	• 7 •
• 8 •	• 8 •	• 8 •
• 9 •	• 9 •	• 9 •
1	2	3

Be very careful to mark the items correctly on the special answer forms. Each of the page numbers in the booklet appears in sequence above a section of the form. Letters identify the seven picture groups. Mark your selected order for the picture groups in the correct lettered columns. Make sure that you do not stray to a wrong page number or column letter and that you give different preference numbers to each picture group.

Please take special care in assigning the first four ranks to the picture groups, but do your best to rank all of the remaining picture groups also. Start ranking your preferences from the best to the worst. If you have difficulty, perhaps choosing the best one or two and then the worst one or two would be helpful. It is important, however, to assign a rank to every picture for each separate idea. You will not be timed for this exercise. We ask you, insofar as possible, to base your rankings on your first impressions of the degree to which the picture groups, each with its changing feature, suggest or imply the idea. Use your booklet as a scratch pad if you like.

Any questions? Raise your hand! When you are ready to proceed with Part I, carefully separate the next page with the seven picture groups from your booklet's staple. Make sure you do not tear any of the pictures! You are to use the page to make your judgments for each idea in Part I of the booklet.

When you have finished with Part I, please continue to Part II. There are instructions for you to read at that time.

PLEASE--RECORD YOUR PREFERENCES ON THE SPECI'L ANSWER SHEETS

FORM B

Part II

Instructions for Part II are similar to those for Part I. On each page of Part II of the booklet, you will find a label for a military branch designation (pages 9-26) or a term indicating the function that a combat unit may perform (pages 27-32). Each page of Part II also includes a series of eight simple pictures. You will see that there are only two different picture series which are used. In the first set of tasks, you have to decide which picture best represents the branch designation, which is second best, third best, and so on. In the second set of tasks, you have to decide the best order for relating the pictures to the unit function. Function terms have been defined for you and examples are given of the military units which typically perform each function. Remember, we are not trying to find out if you know current military symbols. We are looking for your own preference.

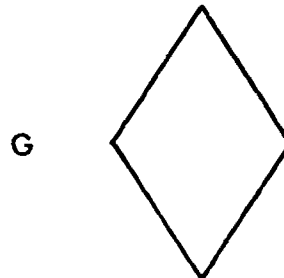
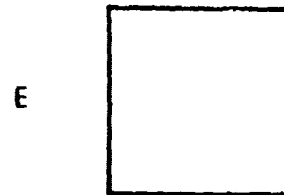
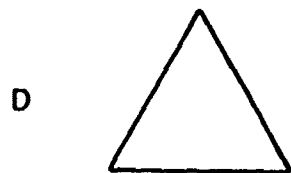
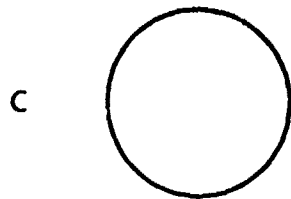
Note that the pictures are arranged differently from page to page. After ranking a picture with respect to its representation of a branch designation or function term, blacken the corresponding numbered space on the answer form in the same manner as described for Part I. Make sure that you do not stray to a wrong page number or column letter and that you give different rank orders to each picture on a booklet page. Two pictures on the same page should never be given the same preference number.

Please take special care in assigning the first four ranks to the pictures, but do your best to rank all of the remaining pictures also. If you have difficulty, perhaps choosing the best one or two and then the worst one or two would be helpful. It is important, however, to assign a rank to every picture on a page. You will not be timed for this exercise. We ask you, insofar as possible, to base your rankings on your first impressions of the degree to which the pictures suggest or imply the branch designations or function terms. You may continue to use the booklet as a scratch pad if you like. Any questions? Raise your hand to alert us to any problems either now or during Part II. Start Part II when you are ready.

PLEASE--RECORD YOUR PREFERENCES ON THE SPECIAL ANSWER SHEETS

ARMOR

Do not assign the same preference order to more than one picture. Put the following pictures in the order that best represents your feelings about the degree to which they suggest or imply the branch designation.



(Example of Form B, Part II of the research)

APPENDIX B

MEAN RANKS, PERCENTAGES OF "BEST" RANKS, AND SIGNIFICANCE RESULTS

The overall results are summarized in Tables B-1 to B-10. Tables B-1 to B-5, based upon the Form A booklet, list the information categories, branch designations, or general function terms in the order in which they were ranked for association with each symbol set or individual symbol. The mean rank of each item is presented below the item. In addition, the percentage of subjects assigning the rank of "1" to the three best items (Tables B-1 to B-3) or to the best item (Tables B-4 to B-5) is indicated in parentheses below the mean rank for those items. Tables B-6 to B-10, based upon Form B, list the symbol sets, geometric forms, or miscellaneous symbols in the order in which they were ranked for association with each information category, branch designation, or general function term. The mean rank for each symbol set or individual symbol is provided below the symbol, and again the percentage of subjects assigning the rank of "1" to the three best items (Tables B-6 to B-8) or to the best item (Tables B-9 to B-10) appears in parentheses below those items. Each column of a table thus represents the outcome for ranking items on a particular page of each of the two booklets.

The distributions of ranks for the items on each page were subjected to a Friedman non-parametric two-way analysis of variance (Siegel, 1956). Levels of significance are indicated by asterisks adjacent to the column heading. All but 8 of the 71 analyses were significant at the .01 level or better. Pair-wise comparisons among the items on a page were made by means of the a posteriori non-parametric Nemenyi test (Kirk, 1969). Since primary interest was in the best item, a bracket is drawn in each column to encompass those items which fail to differ significantly (at the .05 level) from the best item. The narrower the group of items embraced by the bracket, the stronger and more selective presumably is the association between them and the column head. Conversely, the broader the group of items joined by the bracket, the weaker and less selective is their association with the column head. A bracket restricted to the best item indicates that its association with the column head is unique and significantly stronger than that for any other item in the column list. It should also be noted that even when a unique association between the column head and the best item is not evident, the mean rank of the latter may be significantly less than that of some items in the column (i.e., those not embraced by the bracket) whose mean rank does not differ significantly from the mean rank of the second best item. Additional evidence bearing upon the strength of association is provided by the percentage of subjects who assigned the rank of "1" to the best time. This percentage may be compared to the chance percentage for a particular set of ranks. These tables were the basis for the highlights in Tables 1 and 2 of the main text of this report.

Table B-1
Rank Order of Associations Between
Information Categories and Each Symbol Set

Size*	Gr., Scale**	Width**	Color**	Broken/Solid*	Empty/Filled**	Numerosity**
Concentration	Concentration	Unit Level	Danger	Firepower	Concentration	Unit Level
3.91 (20.7%)	3.16 (36.2%)	3.54 (29.3%)	3.10 (38.8%)	3.91 (18.1%)	3.16 (27.6%)	2.48 (56.9%)
Firepower	Danger	Range	Concentration	Range	Danger	Concentration
3.97 (8.7%)	3.61 (20.7%)	4.10 (17.4%)	3.96 (11.2%)	4.16 (16.4%)	4.06 (12.1%)	3.89 (9.5%)
Accuracy	Firepower	Firepower	Importance	Concentration	Importance	Firepower
4.10 (8.6%)	4.18 (6.9%)	4.11 (11.3%)	4.01 (15.5%)	4.19 (14.8%)	4.14 (6.9%)	4.30 (6.9%)
Unit Level	Importance	Concentration	Firepower	Importance	Accuracy	Range
4.12	4.22	4.23	4.72	4.35	4.40	4.50
Importance	Unit Level	Importance	Friend/Enemy	Accuracy	Firepower	Importance
4.32	4.70	4.26	4.82	4.72	4.78	4.64
Range	Accuracy	Accuracy	Accuracy	Unit Level	Unit Level	Danger
4.70	5.14	4.78	4.84	4.75	4.80	5.11
Danger	Range	Danger	Unit Level	Danger	Friend/Enemy	Accuracy
4.74	5.40	4.93	5.17	4.77	5.20	5.28
Friend/Enemy	Friend/Enemy	Friend/Enemy	Range	Friend/Enemy	Range	Friend/Enemy
6.19	5.65	6.00	5.39	5.08	5.50	5.79

* p < .01
** p < .001

Table B-2

Rank Order of Associations Between
Branch Designations and Each Geometric Form

Circle**	Triangle**	Square	Ellipse**	Rectangle*	Diamond**	Parallelogram**	Trapezoid
Signal 3.30 (34.5%)	Armor 4.21 (22.4%)	Engineer 4.53 (21.7%)	Armor 3.77 (29.3%)	Engineer 4.22 (20.7%)	Signal 3.71 (25.9%)	Mechanized Infantry 3.90 (22.6%)	Armor 3.45 (31%)
Air Defense Artillery 4.29 (7.8%)	Field Artillery 4.48 (16.4%)	Armor 4.62 (11.3%)	Mechanized Infantry 4.33 (13.9%)	Mechanized Infantry 4.46 (11.4%)	Engineer 4.22 (16.4%)	Armor 3.99 (25%)	Mechanized Infantry 3.87 (14.7%)
Armor 4.49 (12.9%)	Air Defense Artillery 4.56 (16.4%)	Signal 4.72 (13.8%)	Air Defense Artillery 4.65 (10.3%)	Air Defense Artillery 4.79 (14.8%)	Aviation 4.31 (13.8%)	Cavalry 4.60 (10.3%)	Field Artillery 5.05 (5.2%)
Field Artillery 4.64	Signal 4.97	Mechanized Infantry 4.74	Aviation 4.72	Infantry 5.03	Mechanized Infantry 4.78	Field Artillery 4.85	Air Defense Artillery 5.10
Aviation 4.93	Cavalry 5.09	Air Defense Artillery 4.83	Cavalry 4.93	Field Artillery 5.10	Air Defense Artillery 5.04	Air Defense Artillery 5.29	Infantry 5.22
Mechanized Infantry 5.18	Aviation 5.12	Field Artillery 5.06	Field Artillery 4.99	Armor 5.11	Field Artillery 5.25	Aviation 5.43	Engineer 5.42
Engineer 5.19	Engineer 5.13	Aviation 5.38	Signal 5.53	Signal 5.24	Armor 5.69	Signal 5.47	Cavalry 5.52
Cavalry 6.24	Mechanized Infantry 5.41	Cavalry 5.44	Engineer 5.97	Aviation 5.27	Cavalry 5.86	Infantry 5.64	Signal 5.60
Infantry 6.62	Infantry 5.91	Infantry 5.68	Infantry 6.05	Cavalry 5.68	Infantry 6.13	Engineer 5.75	Aviation 5.76

*p < .01

**p < .001

Table B-3

Rank Order of Associations Between
Branch Designations and Each Miscellaneous Symbol

x**	Arrow**	Cross**	Arc**	Angle**	Bracket	Zigzag**	Line
Infantry	Air Defense Artillery	Aviation	Air Defense Artillery	Aviation	Engineer	Signal	Infantry
4.27 (36.5%)	4.16 (19%)	3.83 (19%)	4.14 (24.1%)	4.46 (17.2%)	4.32 (25%)	4.06 (24.1%)	4.56 (25%)
Field Ar- tillery	Field Artillery	Air Defense Artillery	Field Artillery	Air Defense Artillery	Signal	Field Artillery	Air Defense Artillery
4.58 (9.5%)	4.41 (11.2%)	4.00 (9.6%)	4.19 (17.2%)	4.47 (16.4%)	4.64 (6.1%)	4.67 (13.8%)	4.64 (10.3%)
Air Defense Artillery	Aviation	Engineer	Aviation	Field Artillery	Field Artillery	Aviation	Field Artillery
4.59 (12.9%)	4.72 (16.4%)	4.27 (25%)	4.59 (10.3%)	4.60 (11.2%)	4.89 (9.5%)	4.79 (8.7%)	4.84 (6%)
Signal	Signal	Signal	Signal	Engineer	Air Defense Artillery	Cavalry	Cavalry
4.80	4.88	4.32	4.72	4.95	5.01	4.91	4.98
Aviation	Armor	Field Artillery		Signal	Infantry	Armor	Signal
4.98	4.93	5.21		4.97	5.03	4.97	5.07
Cavalry	Mechanized Infantry	Mechanized Infantry	Cavalry	Armor	Armor	Air Defense	Armor
5.10	5.04	5.62	4.95	5.15	5.04	5.07	5.10
Armor	Infantry	Cavalry	Engineer	Mechanized Infantry	Mechanized Infantry	Engineer	Engineer
5.41	5.37	5.63	5.31	5.22	5.15	5.11	5.15
Mechanized Infantry	Cavalry	Armor	Armor	Cavalry	Cavalry	Mechanized Infantry	Mechanized Infantry
5.52	5.64	6.02	5.34	5.35	5.39	5.37	5.23
Engineer	Engineer	Infantry	Infantry	Infantry	Aviation	Infantry	Aviation
5.74	5.85	6.12	6.05	5.85	5.58	5.96	5.30

*p < .01

**p < .001

Table B-4

Rank Order of Associations Between
General Function Terms and Each Geometric Form

	Parallelogram**	Diamond	Triangle*	Square**	Ellipse*	Trapezoid	Circle**	Rectangle*
Maneuver	1.67 (57.5%)	Fire Support	Maneuver	Service Support	Fire Support	Fire Support	Service Support	Service Support
		1.99 (28.1%)	1.78 (45.2%)	1.59 (61.2%)	1.87 (37.1%)	1.85 (39.7%)	1.70 (47.4%)	1.76 (48.3%)
Fire Support		Service Support	Fire Support	Fire Support	Maneuver	Maneuver	Fire Support	Maneuver
		1.99	2.02	2.16	1.88	2.00	2.09	2.11
Service Support		Maneuver	Service Support	Maneuver	Service Support	Service Support	Maneuver	Fire Support
		2.02	2.20	2.25	2.24	2.14	2.20	2.13

*p < .01

**p < .001

Table B-5

Rank Order of Associations Between
General Function Terms and Each Miscellaneous Symbol

Bracket	Cross**	Zigzag*	Arrow**	Angle**	X**	Line**	Arc
Fire Support	Fire Support	Maneuver	Maneuver	Maneuver	Service Support	Service Support	Fire Support
1.78 (44.8%)	1.70 (47.0%)	1.78 (42.2%)	1.65 (56.5%)	1.62 (58.6%)	1.95 (44.8%)	1.82 (40.9%)	1.91 (38.8%)
Service Support	Maneuver	Fire Support	Fire Support	Fire Support	Fire Support	Fire Support	Service Support
2.09	2.10	2.12	1.94	2.14	1.98	1.91	2.02
Maneuver	Service Support	Service Support	Service Support	Service Support	Maneuver	Maneuver	Maneuver
2.12	2.20	2.21	2.50	2.33	2.32	2.41	2.14

*p .01

**p .001

Table B-6

Rank Order of Associations Between
Symbol Sets and Each Information Category

Accuracy**	Concentration**	Danger**	Importance**	Friend/Enemy**	Range**	Firepower**	Unit Level**
Color 3.31 (38.0%)	Gray Scale 3.17 (27.7%)	Color 2.36 (64.2%)	Color 3.25 (38.5%)	Color 2.81 (40.9%)	Size 3.31 (32.8%)	Numerosity 3.41 (18.2%)	Numerosity 2.47 (49.6%)
Width 3.86 (7.3%)	Numerosity 3.54 (21.9%)	Gray Scale 3.42 (10.9%)	Numerosity 3.69 (17.8%)	Empty/Filled 3.17 (23.4%)	Gray Scale 3.79 (16.1%)	Empty/Filled 3.52 (22.6%)	Size 3.88 (19.0%)
Size 3.96 (16.8%)	Empty/Filled 3.72 (16.1%)	Empty/Filled 3.44 (10.9%)	Empty/Filled 3.84 (13.3%)	Gray Scale 3.38 (12.4%)	Numerosity 3.80 (19.7%)	Gray Scale 3.89 (10.2%)	Empty/Filled 3.96 (8.8%)
Empty/Filled	Width	Numerosity	Size	Size	Broken/Solid	Color	Width
3.96	3.98	4.42	3.90	4.45	3.88	4.06	3.97
Numerosity	Size	Width	Gray Scale	Broken/Solid	Width	Size	Gray Scale
4.00	4.10	4.69	3.99	4.57	4.24	4.10	4.45
Gray Scale	Broken/Solid	Size	Width	Numerosity	Empty/Filled	Width	Broken/Solid
4.23	4.47	4.71	4.56	4.79	4.33	4.20	4.59
Broken/Solid	Color	Broken/Solid	Broken/Solid	Width	Color	Broken/Solid	Color
4.66	5.02	4.96	4.73	4.85	4.66	4.83	4.67

** p < .001

Table B-7

Rank Order of Associations Between
Geometric Forms and Each Branch Designation

Infantry**	Armor**	Field Artillery**	Mechanized Infantry**	Signal**	Engineer**	Air Defense Artillery**	Cavalry**	Aviation*
Square 3.63 (15.3%)	Parallelo-gram 3.63 (19.1%)	Triangle 3.65 (26.3%)	Parallelo-gram 3.29 (21.2%)	Diamond 3.31 (36.5%)	Trapezoid 3.80 (27%)	Triangle 3.31 (38.7%)	Parallelo-gram 4.31 (10.2%)	Triangle 3.50 (24.3%)
Diamond 3.69 (17.5%)	Triangle 3.99 (21.3%)	Diamond 3.83 (16.8%)	Trapezoid 4.18 (13.1%)	Circle 3.45 (24.1%)	Rectangle 4.02 (10.9%)	Diamond 3.53 (16.8%)	Ellipse 4.34 (16.1%)	Diamond 3.71 (19.1%)
Triangle 3.87 (20.4%)	Trapezoid 4.0 (20.6%)	Ellipse 4.92 (19.5%)	Rectangle 4.30 (9.5%)	Triangle 4.06 (10.2%)	Square 4.15 (13.1%)	Trapezoid 4.21 (8%)	Triangle 4.38 (17.5%)	Trapezoid 4.07 (14.7%)
Rectangle 3.93	Ellipse 4.37	Trapezoid 4.64	Ellipse 4.38	Square 4.14	Parallelo-gram 4.35	Circle 4.61	Trapezoid 4.42	Circle 4.65
Trapezoid 4.52	Rectangle 4.88	Square 4.72	Triangle 4.75	Rectangle 4.89	Triangle 4.37	Ellipse 4.75	Rectangle 4.46	Ellipse 4.69
Circle 5.02	Diamond 4.93	Parallelo-gram 4.91	Diamond 4.80	Trapezoid 5.18	Diamond 4.56	Parallelo-gram 4.91	Diamond 4.53	Rectangle 5.00
Parallelo-gram 5.36	Circle 4.99	Ellipse 4.92	Square 5.14	Ellipse 5.42	Ellipse 5.28	Square 5.17	Square 4.64	Parallelo-gram 5.13
Ellipse 6.00	Square 5.23	Rectangle 4.98	Circle 5.16	Parallelo-gram 5.56	Circle 5.49	Rectangle 5.52	Circle 4.93	Square 5.25

** p < .001

Table B-8

Rank Order of Associations Between
Miscellaneous Symbols and Each Branch Designation

Infantry**	Armor**	Field Artil- lery**	Mechanized Infantry**	Signal**	Engineer**	Air Defense Artillery**	Cavalry**	Aviation*
Angle 2.85 (32.8%)	Arc 3.46 (22.6%)	Angle 3.83 (17.5%)	Angle 3.65 (16.8%)	Zigzag 3.02 (44.5%)	Bracket 3.58 (29.2%)	Angle 3.10 (29.9%)	Angle 3.72 (14.6%)	Angle 3.34 (23.4%)
Arrow 3.30 (21.2%)	Angle 3.92 (21.2%)	Cross 3.90 (18.2%)	Arrow 3.75 (19.0%)	X 3.88 (13.1%)	X 4.18 (10.9%)	Arrow 3.92 (24.8%)	Arrow 3.79 (21.2%)	Arrow 3.81 (21.2%)
X 4.35 (23.4%)	Arrow 3.94 (14.6%)	Arrow 4.23 (23.4%)	Arc 4.23 (10.9%)	Cross 4.37 (8.0%)	Arc 4.26 (9.5%)	Arc 4.12 (11.7%)	Arc 4.20 (17.5%)	Arc 4.18 (14.6%)
Arc 4.46	X 4.48	X 4.29	Zigzag 4.50	Arc 4.71	Cross 4.29	Zigzag 4.42	X 4.46	X 4.47
Line 4.55	Cross 4.60	Arc 4.67	Cross 4.50	Bracket 4.96	Zigzag 4.43	Cross 4.52	Zigzag 4.79	Cross 4.58
Cross 5.33	Zigzag 4.77	Zigzag 4.74	X 4.54	Arrow 4.97	Angle 4.72	X 4.89	Cross 4.86	Zigzag 4.91
Bracket 5.53	Bracket 4.94	Bracket 4.82	Bracket 4.94	Angle 5.02	Line 5.26	Bracket 5.25	Bracket 4.87	Line 5.22
Zigzag 5.64	Line 5.89	Line 5.52	Line 5.89	Line 5.08	Arrow 5.29	Line 5.77	Line 5.32	Bracket 5.49

**p < .001

Table B-9

Rank Order of Associations Between
Geometric Forms and Each General Function Term

Fire Support**	Service Support	Maneuver Unit**
Triangle 3.91 (19.9%)	Square 3.87 (19%)	Triangle 3.13 (34.3%)
Parallelogram 4.35 (12.5%)	Circle 4.05 (21.9%)	Diamond 3.45 (21.2%)
Square 4.37 (10.3%)	Trapezoid 4.26 (14.6%)	Parallelogram 4.39 (10.2%)
Circle 4.54	Rectangle 4.30	Ellipse 4.53
Trapezoid 4.59	Ellipse 4.38	Trapezoid 4.91
Diamond 4.63	Parallelogram 4.72	Circle 5.18
Rectangle 4.78	Triangle 5.18	Square 5.21
Ellipse 4.82	Diamond 5.24	Rectangle 5.22

** p < .001

Table B-10

Rank Order of Associations Between
Miscellaneous Symbols and Each General Functions Term

Fire Support**	Service Support**	Maneuver Unit**
Arrow 3.68 (19.7%) Angle 3.96 (14.6%) Cross 3.99 (16.1%) Arc 4.12 X 4.27 Zigzag 4.91 Bracket 5.32 Line 5.75	Bracket 3.58 (20.4%) Arc 3.90 (16.1%) Cross 4.25 (16.1%) Zigzag 4.38 Line 4.45 Angle 4.47 X 5.04 Arrow 5.94	Arrow 2.90 (36.5%) Angle 3.29 (22.6%) Arc 4.51 (5.1%) Zigzag 4.57 X 4.59 Cross 4.85 Bracket 5.45 Line 5.83

**p < .001

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 4 Dir Psych, Army Hq, Russell Ofcs, Canberra
 1 Scientific Advser, Mil Bd, Army Hq, Russell Ofcs, Canberra
 1 Mil and Air Attache, Austrian Embassy
 1 Centre de Recherche Des Facteurs, Humaine de la Defense Nationale, Brussels
 2 Canadian Joint Staff Washington
 1 C/Air Staff, Royal Canadian AF, ATTN: Pers Std Anal Br
 3 Chief, Canadian Def Rsch Staff, ATTN: C/CRDS(%)
 3 British Def Staff, British Embassy, Washington

1 Def & Civil Inst of Enviro Medicine, Canada
 1 AIR CRESS, Kensington, ATTN: Info Sys Br
 1 Militærpsykologisk Tjeneste, Copenhagen
 1 Military Attache, French Embassy, ATTN: Doc Sec
 1 Medecin Chef, C.E.R.P.A.-Arsenal, Toulon/Naval France
 1 Prin Scientific Off, Appl Hum Engr Rsch Div, Ministry of Defense, New Delhi
 1 Pers Rsch Ofc Library, AKA, Israel Defense Forces
 1 Ministeris van Defensie, DOOP/KL Afd Sociaal Psychologische Zaken, The Hague, Netherlands